CENTER FOR BEAM PHYSICS SEMINAR

"A Compact Hadron Therapy Accelerator"

Bill Chu, LBNL

Friday, March 22, 2002, 10:30 AM
Albert Ghiorso Conference Rm. (71-264), LBNL
Refreshments served at 10:20 AM

Abstract: For the past five decades, LBNL has pioneered the clinical use of accelerated hadron (proton and light-ion) beams for treatment of human cancer. By now, seven proton therapy facilities and two light-ion facilities have been constructed in hospitals, and many more are planned. Based on its excellent dose localization characteristics, protons compete well against the conventional gamma ray and electron beam treatment; but, recent developments in "intensity modulation radiation therapy" (IMRT) brought the efficacy of conventional radiation very close to that of protons. Light ions, such as carbon nuclei, possess additional biological advantages in treating human cancer over protons or gamma rays. Following the Heavy Ion Medical Accelerator in Chiba IHIMAC) built in the '90s, a new carbon-ion facility was commissioned in Hyogo, Japan in 2001, and another had its ground breaking in Heidelberg, Germany. The main drawback of a carbon-ion facility is its large capital cost.

We propose constructing a next-generation hadron therapy facility based on a specially developed superconducting cyclotron that would accelerate ions with charge-to-mass ratio of 1/2 (for example, H_2^{1+} and C_{12}^{6+}), with an ECR ion source, dynamic intensity control, and multiple extraction ports of high extraction efficiency. The extracted beam intensity may be fully modulated by a factor of 1000 within 50 μs, which would make the facility uniquely suitable for beam scanning for three-dimensional conformal therapy delivery. The facility would provide selected light ions, such as fully stripped carbon nuclei, with an energy per nucleon of 250 MeV. The facility may be upgraded to boost the energy per nucleon to 350 MeV by adding superconducting cavities of a length of approximately 9 m. The light ions will be used in clinic as well as in research; and when upgraded, it would compare favorably against light-ion clinical facilities being developed around the world at a much larger cost.

Biographical data: Bill Chu is Senior Scientist in the Life Science Division, and Leader of Medical Accelerator Applications in the Ion Beam Technology Group in AFRD. He earned his Ph.D. in experimental particle physics at Carnegie–Mellon University, and after spending two years at the Brookhaven National Laboratory (BNL), he moved to the Ohio State University as Assistant Professor of Physics where he conducted experiments at the ZGS of the Argonne National Laboratory. In 1971 Bill moved to Loma Linda University Medical School where he rose to Professor of Radiation Sciences (1978). During his tenure at Loma Linda, Bill developed his interest in hadron therapy– he studied the clinical use of negative pions at the AGS at BNL, then light-ion therapy at Bevatron at LBNL. In 1979 AFRD appointed him to head the biomedical research conducted at the Bevalac, and later he was promoted to Senior Scientist in the Life Science Division. He has directed numerous hadron therapy research projects as Principal Investigator for DOE and NCI/NIH. He served as PI in a DOE CRADA with General Atomics of San Diego, which was the major U.S. contractor to build the Northeast Proton Therapy Center at the Massachusetts General Hospital in Boston. Recognizing his contribution, the Federal Laboratory Consortium in 2000 awarded to Bill its coveted FLC–2000 Award for Excellence in Technology Transfer. He is one of the founders of the Particle Therapy Cooperative Group (PTCOG). Currently Bill is Principal Investigator of a DOE project on "Accelerator-Based Boron Neutron Capture Therapy (BNCT) Clinical Trials" and a DOE Initiative for Proliferation Prevention (IPP) project, "Neutronics Computational Tools for Medicine and Industry" to engage thermonuclear weapons scientists in Russia for peaceful technology development.